Foundations of Modern Networking

SDN, NFV, QoE, IoT, and Cloud

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Chapter 6

SDN Application Plane

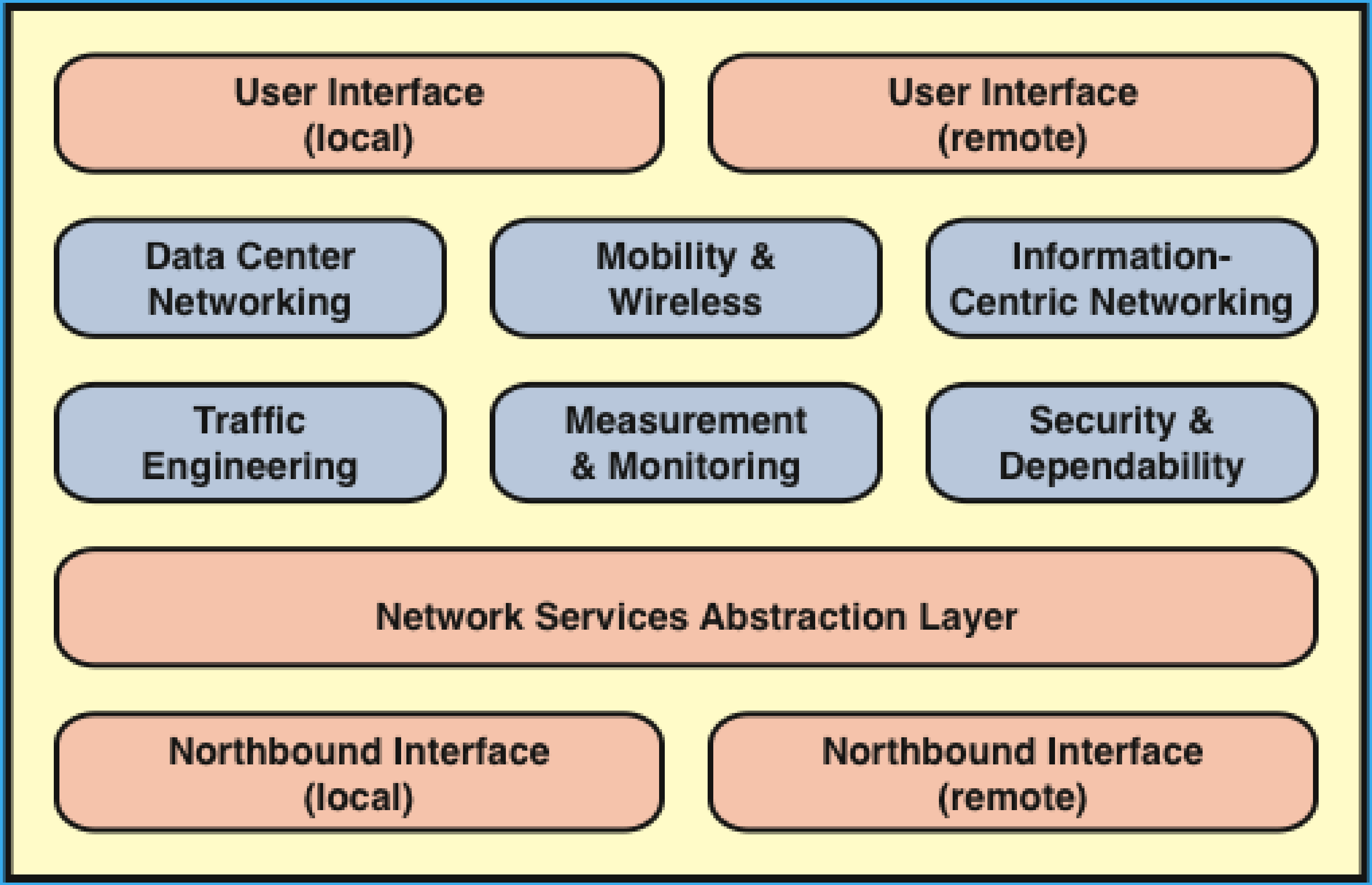

Figure 6.1 SDN Application Plane Functions and Interfaces

Northbound Interface

- Enables applications to access control plane functions and services without needing to know the details of the underlying network switches
- Typically, the northbound interface provides an abstract view of network resources controlled by the software in the SDN control plane
- Can be a local or remote interface
    - For a local interface, the SDN applications are running on the same server as the control plane software
    - On remote systems the northbound interface is a protocol or application programming interface (API) that connects the applications to the controller network operating system (NOS) running on central server

Network Services Abstraction Layer

RFC 7426 defines a network services abstraction layer between the control and application planes and describes it as a layer that provides service abstractions that can be used by applications and services

Several functional concepts are suggested by the placement of this layer in the SDN architecture:

This layer could provide an abstract view of network resources that hides the details of the underlying data plane devices	This layer could provide a generalized view of control plane functionality, so that applications could be written that would operate across a range of controller network operating systems	This functionality is similar to that of a hypervisor or virtual machine monitor that decouples applications from the underlying OS and underlying hardware	This layer could provide a network virtualization capability that allows different views of the underlying data plane infrastructure

Network Services Abstraction Layer

- An abstraction layer is a mechanism that translates a high-level request into the low-level commands required to perform the request
- It shields the implementation details of a lower level of abstraction from software at a higher level
- A network abstraction represents the basic properties or characteristics of network entities in such a way that network programs can focus on the desired functionality without having to program the detailed actions

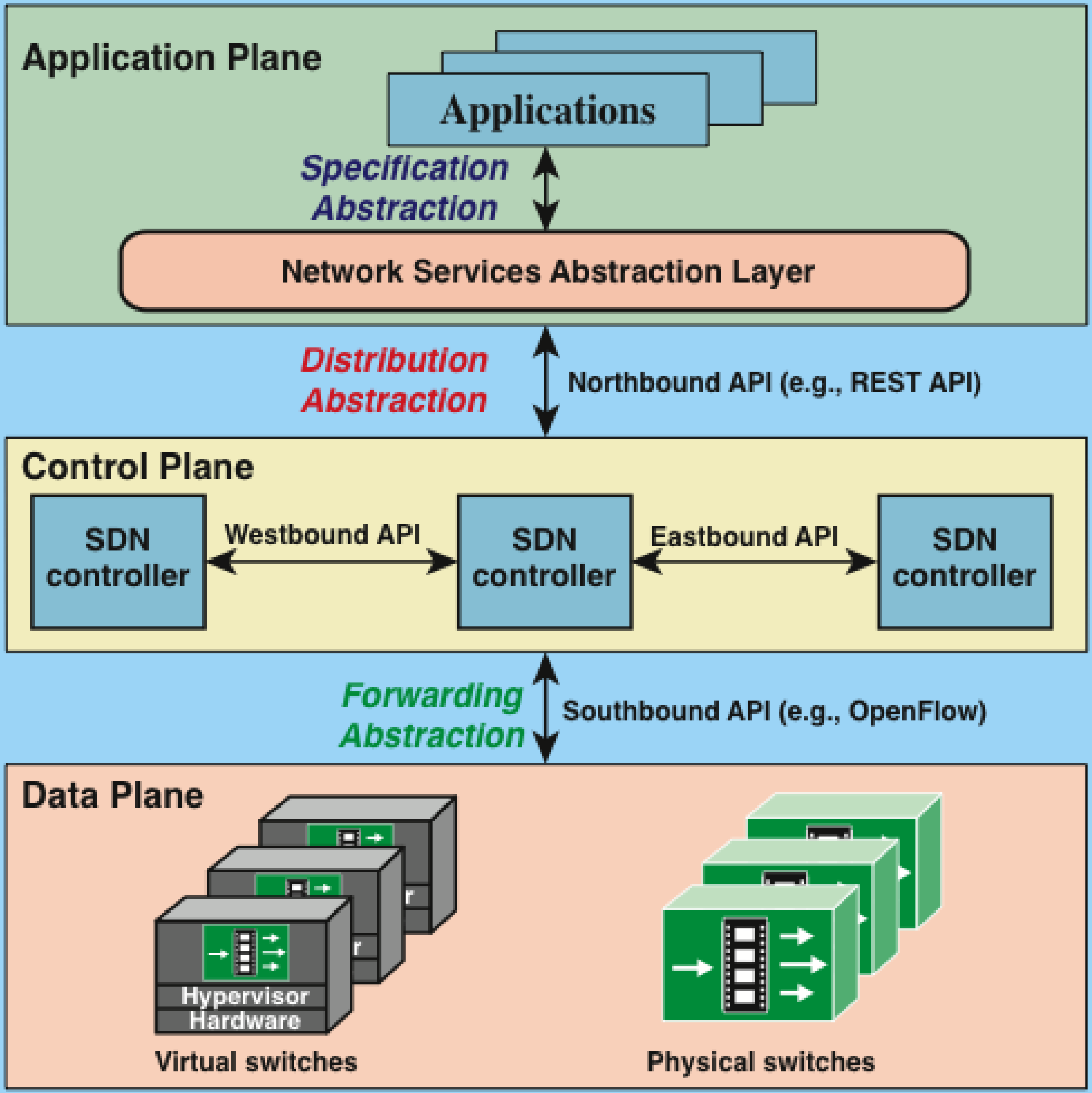

Figure 6.2 SDN Architecture and Abstractions

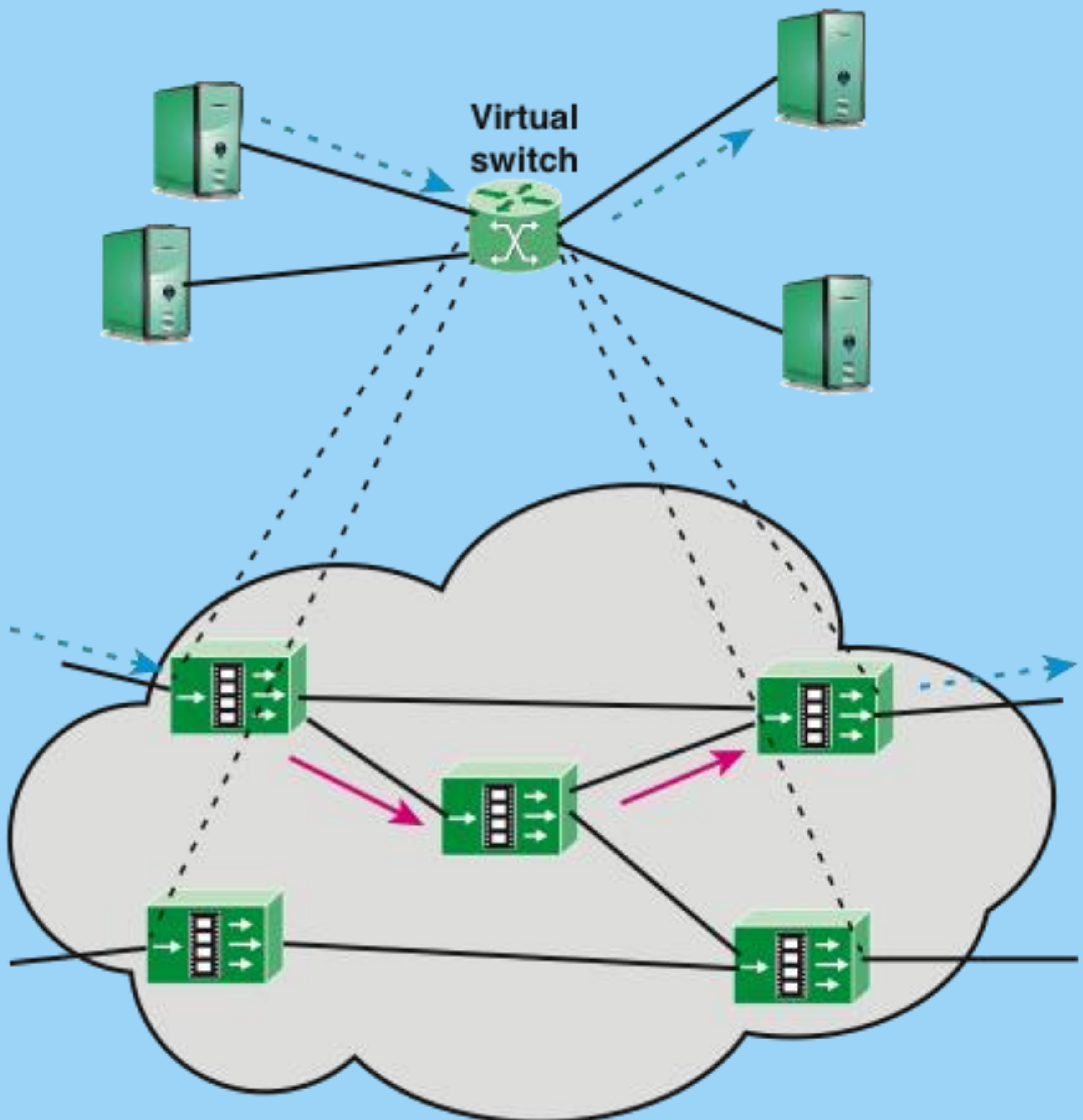

Figure 6.3 Virtualization of a Switching Fabric for MAC Learning

Traffic Engineering

- A method for dynamically analyzing, regulating, and predicting the behavior of data flowing in networks with the aim of performance optimization to meet service level agreements (SLAs)
- Involves establishing routing and forwarding policies based on QoS requirements
- With SDN the tasks of traffic engineering should be considerable simplified compared with a non-SDN network
- The following traffic engineering functions have been implemented as SDN applications:
  - On-demand virtual private networks
  - Load balancing
  - Energy-aware routing
  - QoS for broadband access networks
  - Scheduling/optimization
  - Traffic engineering with minimal overhead
  - Dynamic QoS routing for multimedia apps
  - Fast recovery through fast-failover groups
  - QoS policy management framework
  - QoS enforcement
  - QoS over heterogeneous networks
  - Multiple packet schedulers
  - Queue management for QoS enforcement
  - Divide and spread forwarding tables

PolicyCop

- An instructive example of a traffic engineering SDN application, which is an automated QoS policy enforcement framework
- It leverages the programmability offered by SDN and OpenFlow for:
    - Dynamic traffic steering
    - Flexible Flow level control
    - Dynamic traffic classes
    - Custom flow aggregation levels
- Key features of PolicyCop are that it monitors the network to detect policy violations and reconfigures the network to reinforce the violated policy

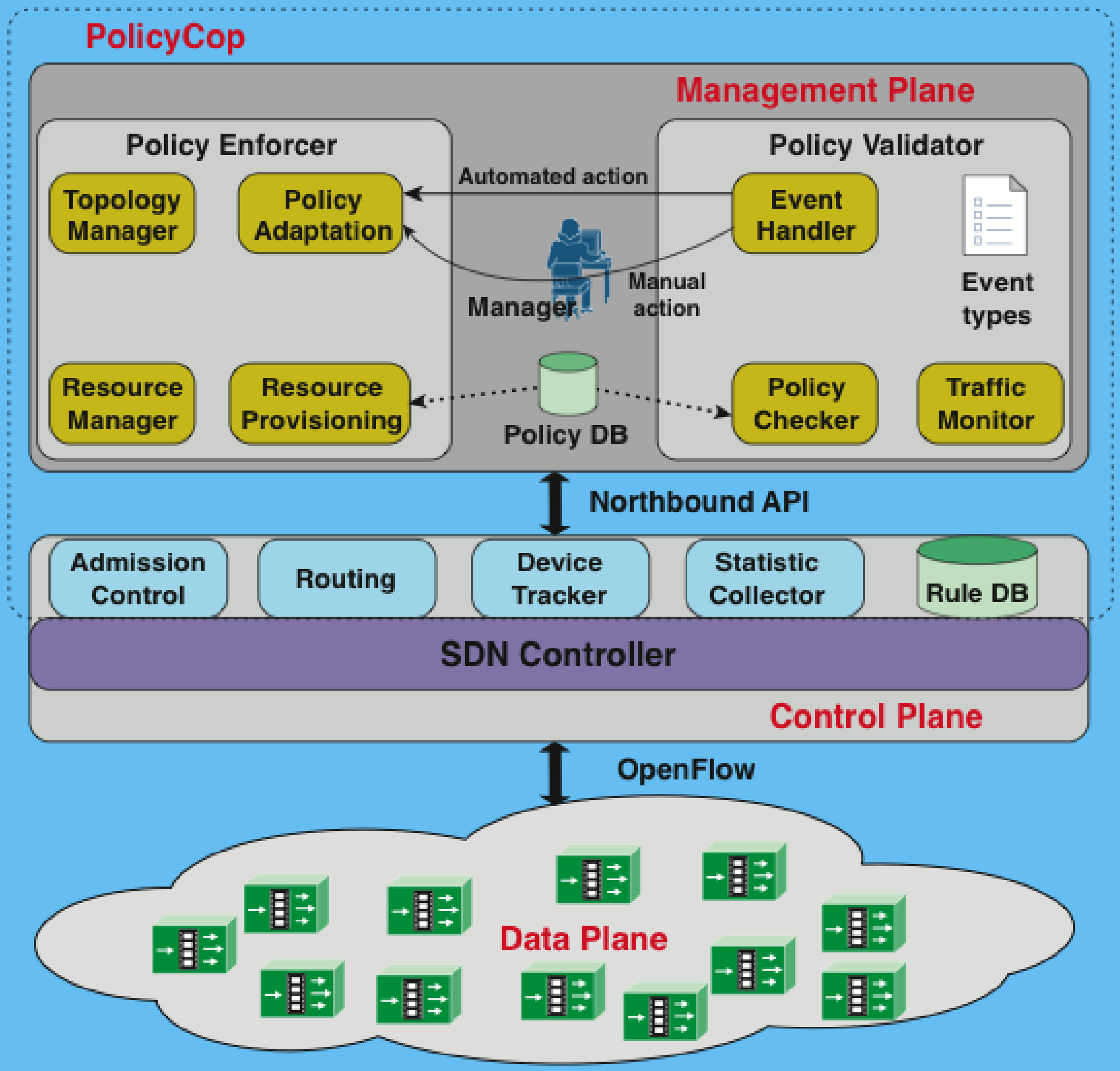

Figure 6.5 PolicyCop Architecture

Table 6.1 Functionality of Some Example Policy Adaptation Actions (PAAs)

SLA Parameter	PAA Functionality
Packet loss	Modify queue configuration or reroute to a better path
Throughput	Modify rate limiters to throttle misbehaving flows
Latency	Schedule flow through a new path with less congestion and suitable delay
Jitter	Reroute flow through a less congested path
Device Failure	Reroute flows through a different path to bypass the failure

Measurement and Monitoring

- The area of measurement and monitoring applications can roughly be divided into two categories:
  - Applications that provide new functionality for other networking services
    - An example is in the area of broadband home connections
      - If the connection is to an SDN-based network, new functions can be added to the measurement of home network traffic and demand, allowing the system to react to changing conditions
  - Applications that add value to OpenFlow-based SDNs
    - This category typically involves using different kinds of sampling and estimation techniques to reduce the burden of the control plane in the collection of data plane statistics